DOCUMENT RESUME

ED 207 133 EA 013 838

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TITLE Energy and Education.
INSTITUTION Appalachia Educational Lab., Charleston, W. Va.
SPONS AGENCY National Inst. of Education (ED), Washington, D.C.
REPORT NO AEL-OP-005
PUB DATE May 81
NOTE 24p.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Bus Transportation; *Cost Effectiveness; *Educational Facilities; Elementary Secondary Education; *Energy Conservation; Expenditures; Fuel Consumption; Student Transportation
IDENTIFIERS Energy Audits; West Virginia (Mercer County)

ABSTRACT

By initially demonstrating that rising energy costs are threatening to force educational decision-makers to curtail educational programs, this paper suggests a number of energy-saving options for school administrators and presents a case study of energy conservation. Suggestions concerning energy conservation in school facilities are drawn from several published sources. These suggestions include forming an energy management team of representatives from the school and community and preparing detailed energy use reports, energy miniaudits by energy team members in each facility, and maxiaudits conducted by hired experts. Sources for the funding of energy projects are suggested. Maintenance and measures requiring capital investment are discussed. A brief section regarding energy-saving in transportation systems cites suggestions from a U.S. Department of Transportation publication. The final section of the paper presents a program to save money in a school transportation system used in Mercer County, West Virginia. This program used rerouting and rescheduling to cut its 102 buses to 94, conducted a bus driver training course on techniques to promote school economy, and instituted a maintenance program designed to save fuel. The paper concludes that a successful district-wide energy conservation program requires participation and commitment. (Author/JM)

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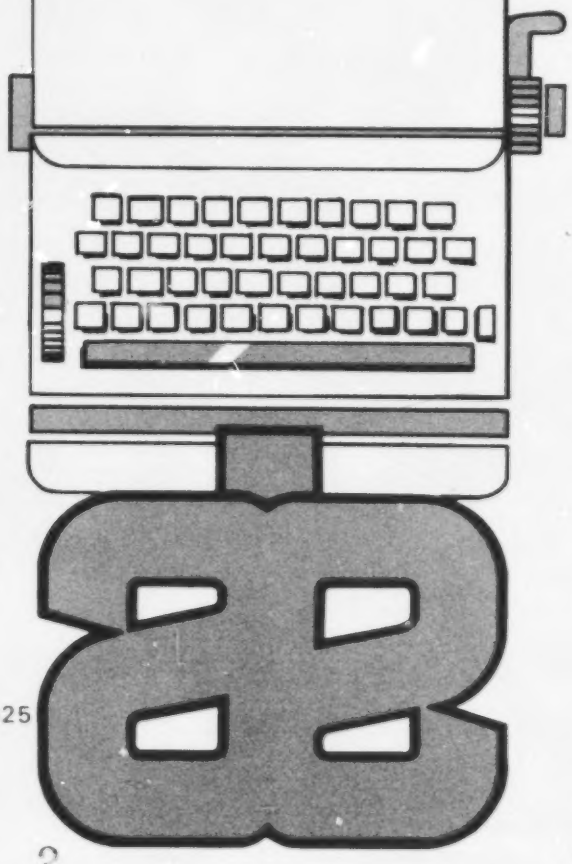

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EA 013 838

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May 1981

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PREFACE

The AEL Regional Exchange Program commissioned this Occasional Paper from J. Douglas Machesney. Dr. Machesney is a former chairperson of the Regional Exchange Advisory Committee and former Assistant Superintendent for Planning, Research, and Evaluation with the West Virginia Department of Education.

Energy conservation in schools is an R & D specialty the author has practiced for several years. Now in private business with Don R. Richardson Associates of Charleston, West Virginia, Dr. Machesney devotes much of his professional time to work with school systems on energy-related matters.

ENERGY AND EDUCATION

BY J. DOUGLAS MACHESNEY

I. INTRODUCTION

Our view of energy is very different today than it was ten years ago. During the 1970's Americans had to face harsh realities about their energy future. The beginning of the decade saw declining production of domestic oil and natural gas combined with increasing oil imports. Then in 1973-74 the Arab oil embargo spelled an abrupt end to cheap energy: petroleum supplies were cut and prices raised to what was then considered to be an outrageous level. Consumers reacted by conserving energy and, through the lessening of demand, prices eased. By the mid-Seventies the "Arab Oil Crisis" appeared to have ended, and there appeared to be a comfortable margin between the world oil demand and the potential supply that many thought would be long-lasting. However, the Iranian revolution and subsequent political circumstances had a significant effect on the supply-and-demand balance, and prices again increased sharply. It now appears that oil prices will continue to rise and, consequently, energy matters will become an even greater factor in our economy generally, and in the operation of school systems specifically.

A recent study of the Shell Oil Company indicates that the total U.S. energy demand from 1965 to 1970 grew almost 5 percent per year, and the projected annual growth rate for 1980 to 1990 is only 1.2 percent. The study listed higher energy prices,

conservation and modest growth in real Gross National Product as contributors to the low rate of growth.[1] The study also indicated that the energy demands of the residential/commercial market (which includes schools and other public buildings) will remain constant at about 22 percent of the total demand through the 1980's. Although there will be growth in the demand for energy for this sector, it will be offset through energy conservation measures.[2]

School systems, as well as other public bodies, are unlike other segments of the economy in that increasing energy costs cannot be recovered by increasing the costs of a product or charging a higher fee. Two options are available to school systems for meeting increasing costs of energy: raise taxes or cut educational programs. It is unlikely, given the political climate of this country today, that attempts to raise taxes will be successful. Therefore, school systems are faced with continued inflation, rising energy costs and extremely tight resources.

The problems are compounded even more by the fact that a high percentage of the school buildings were constructed and transportation systems were designed when energy was cheap.

Former U.S. Commissioner of Education, Ernest L. Boyer, stated the following concerning the schools and energy:

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[1] The National Energy Outlook, 1980-1990, Shell Oil Company, August 1980, p.6.

[2] Ibid., p.8.

> "Our nation's schools consume 11 percent of the heating and cooling fuel in this country; yet it has been estimated that almost half the energy they consume is wasted because school buildings were constructed without regard to energy conservation. There are 79,000 elementary schools in the United States. The most conservative estimate available indicates that at least 50 percent of them need major retrofitting.
>
> The Federal Energy Administration has estimated that if only 30 percent of the nation's elementary and secondary schools were to become energy efficient through renovation and winterization, 25 million barrels of oil could be saved each year.
>
> The Department of Commerce has indicated that with no capital modifications at all — simply by changing operating methods — schools can reduce their energy consumption by 5 to 25 percent. With minor capital modifications, involving very small expenditures, another 25 to 35 percent could be saved.
>
> In 1972-73, the schools spent $1 billion on energy. In 1976-77, the bill was over $2 billion. This accounted for $19.81 per student in 1972 and $41.60 last year. . . . School districts will have no choice but to find more and more ways to conserve energy. Some will establish full or part-time 'energy coordinators' and energy conservation teams. They will develop energy management plans and conduct a school energy audit. They will adopt good plant maintenance practices, including preventive maintenance. And they will ensure that new construction is designed and built to save energy."[3]

Commissioner Boyer cited a doubling of school energy costs from 1972-73 to 1976-77. The U.S. Department of Energy in 1977 predicted annual cost increases of 5 to 12.2 percent until 1990.[4] That now appears to be an ultraconservative estimation. Rising

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[3] Ernest L. Boyer, "Energy and the Schools", Today's Education, Vol.66, No.3, Sept.-Oct. 1977, pp. 54-58.

[4] U.S. Department of Energy Annual Report to Congress, 1977, Volume 1, DOE/EIA-0036/2, Washington, D.C. 20461.

fuel costs for school transportation systems are dramatically illustrated by the graph shown in Exhibit 1, which shows the fuel costs for the years 1973-74 to 1980-81 for the Mercer County, West Virginia, Schools.

The National Association of State Directors of Pupil Transportation Services has published data that describe significant increases in school transportation costs. In 1969-70 the national average per-student expenditure for school transportation was $51.51, and by 1977-78 the average expenditure for that function had increased to $131.69 per student.[5]

Of course, school administrators are not surprised by the grim energy picture presented above, nor have they complacently sat back and done nothing to ease the situation.

According to a study conducted by the American Association of School Administrators (AASA), school building energy consumption in the U.S. on a square-foot basis declined 37 percent from 1973 to 1979. The study pointed out that in 1978, 25 percent of all school buildings relied on oil. In 1979 that figure dropped to 19 percent. In 1978-79 alone, the study found, the nation's public schools reduced energy consumption 2.3 percent, lowering square foot consumption from 104,445 BTU's in 1978 to 102,060 in 1979.[6]

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[5] School Bus Fleet—Fact Book, Vol. 24, No. 6, December-January, 1980, p.69.

[6] AASA Energy Use Study, AASA, Arlington, Virginia, 1980.

II. OPTIONS FOR SCHOOL ADMINISTRATORS

The problem is evident: school systems are faced with the dramatic influence of energy costs, an influence so great that it may be detrimental to the main purpose of schools — education. Educational administrators really do not have any choice but to conserve energy. Energy has to be expended as efficiently as possible, because we are rapidly depleting its sources and, futhermore, its costs are constantly increasing.

A. FACILITIES

The keys to energy conservation and management in the schools are planning and, perhaps most importantly, committment and personal involvement at all levels within the school system from Board of Education members to students. While many methods of involving school and community leaders in energy programs have been developed, the model advanced by the Council of Educational Facilities Planners, International, in the publication entitled Energy Sourcebook for Educational Facilities, represents a sound basic approach to energy management in school systems. This energy management model places strong emphasis on the use of an "energy management team", consisting of a cross-section of representatives of the school and lay communities. CEFP energy program activities have flexibility and therefore enhance the adaptation of the basic program to fit any school system's particular set of circumstances. The basic activities of the program developed by CEFP are as follows:

1. Accurate, detailed energy use reports are prepared for each facility in the district.
2. The energy management team receives training in conducting mini-audits.
3. Mini-audits are conducted in each facility to determine what immediate changes can be made in the use of school buildings and equipment, which will reduce fuel consumption.
4. Technical experts are hired to conduct maxi-audits, which identify building and equipment modifications, which in turn will lower fuel costs.
5. The energy management team analyzes the mini/maxi-audit results and develops a program for modifying habits of building users (like turning out unneeded lights, lowering thermostats, etc.). The program involves mainly information dissemination, energy conservation publicity and encouragement.
6. Maxi-audit results and recommendations are analyzed with respect to time and cost/benefits; alternative energy management programs are developed.
7. The preferred energy management plan is selected by the team and submitted to the Energy Management Committee for approval.[7]

Much has been written on the specific steps that must be followed in conducting the actual mini- or maxi-audits. State

[7] Edmond A. LeBlanc, "Guidelines for Developing an Energy Management Plan for Local School Districts," Energy Sourcebook for Educational Facilities, CEFP, Columbus, Ohio 43210.

energy offices and the U.S. Department of Energy are perhaps the best sources of information. The CEFP Energy Sourcebook for Educational Facilities contains detailed information concerning audit procedures. Instructions for Energy Auditors is a very comprehensive manual that has been prepared for the U.S. Department of Energy by the American Institute of Industrial Engineers and is to be used as a guide for energy auditors.

It should be pointed out that many of the energy-saving measures in facilities are common-sense, no- or low-cost, low technology items that can be identified and implemented by the school system staff. However, as the development of an energy management program reaches higher levels of analyses — analyses of complex heating, ventilating and air-conditioning systems, and engineering analyses of the building's shell and other related factors — professional technical assistance is necessary. A dilemma is therein presented for school administrators: money must be spent to save energy and, although saving energy will ultimately save money (or, with rising costs and inflation, provide for cost avoidance), finding funds for the initial capital expenditures may be a problem.

At the present time, there are three basic alternatives for funding energy projects:

— Participation in the U.S. Department of Energy sponsored programs.

— Energy management programs using local education agency funds.

— Incentive programs.

U.S. Department of Energy funds are focused in two programs: Technical Assistance (TAP's) and Energy Conservation Measures (ECM's).

TAP's are engineering analyses of buildings conducted by registered professional engineers/architects that lead to identification of retrofit measures that when implemented will result in energy savings. Experience in West Virginia has shown that savings ranging from 22 to 59 percent of the annual energy consumption can be achieved as a result of the program. Exhibit 2 illustrates the results in several schools in West Virginia.

The ECM program provides Federal funds to implement the Energy Conservation Measures identified in the TAP's. Both Federal programs are funded on a matching basis. Some hardship funding (80 percent Federal, 20 percent local) is available, but most grants are 50 percent matching. Two of three cycles of both TAP and ECM grants have been awarded, and the third cycle will be awarded in the spring of 1981. Future availability of Federal funding following the third cycle is unknown.

A critical issue facing school boards and school administrators is the expenditure of local funds to pay for Energy Conservation Measures. Faced with increasing energy costs, inflation and rising costs in general, school administrators are forced to choose between reducing programs and services or making expenditures (which also detract from programs) to save energy.

This is the recurring dilemma. School officials must look for the lower-cost, high energy-saving, short payback Energy Conservation Measures in order to make the most efficient use of local funds.

The Kanawha County, West Virginia, Board of Education has undertaken a unique approach to funding energy conservation projects. The Kanawha County Board of Education contracted with the WEX Corporation, a West Virginia energy management firm, to conduct a pilot energy conservation project in an elementary school. The unique aspect of the project is that the fee paid to the contractor will be derived entirely from the cost of the energy saved over a two-year period. Energy consumption for the year 1979 has been established as the base from which the savings will be determined. Project year energy consumption will be adjusted by a degree-day factor to eliminate temperature differences between the base and project years. Capital expenditures are also made by the energy management firm.

What can be done to make school facilities more energy—efficient? Some of the obvious no- or low-cost measures are reduced heating and cooling requirements, reduced lighting, reduced ventilation air flow, and night setback. As the Energy Conservation Measures become more complex, they may also require capital expenditures of varying magnitude. However, many Energy Conservation Measures, although requiring capital expenditures, may in fact cause greater energy savings — and thus a quicker

payback — than low-cost items. As seen in Exhibit 2, the Mineral County Vocational School is estimated to have an annual energy savings of $27,040 after an expenditure of $50,950. The payback for this project is estimated to be 1.9 years. Compared to other projects with smaller ECM expenditures, but longer payback, the Mineral County Vocational School energy conservation project is a very attractive one for the Board of Education.

More costly energy-saving measures that involve capital expenditures are such items as control systems; new or altered heating, ventilating and air-conditioning systems; reduction in exterior glass surface; storm windows or window replacements; and ventilation.

According to a survey taken as part of the AASA Energy Use Study cited earlier, maintenance and capital investment are thought to be the most important factors in reducing energy consumption in schools. Maintenance procedures such as greater upkeep of equipment and facilities were thought to be very important, or important, by 63 percent of the school districts that had decreases in energy consumption. Capital investment was rated as very important by 59 percent of the school districts. Two other factors given as options to the survey respondents — change of operation and low-cost measures — were rated as important, or very important, by less than 5 percent of the districts.[8]

[8] AASA Energy Use Study, p.10

Although opinion varies as to the most effective means of reducing energy consumption in schools, the evidence is overwhelming that energy can be saved.

B. TRANSPORTATION

School transportation systems have not received as much attention in energy conservation efforts as have facilities but, as is evidenced by the data presented in earlier sections, energy costs for transportation constitute a significant portion of the energy problem facing school administrators. Review of the development of school transportation programs reveals that generally such systems have evolved in a haphazard manner with little attention given to maximizing fuel efficiency. Routes and stops have been added, and population trends have not been systematically reviewed to eliminate unneeded runs. Transportation systems, like facilities, were developed at a time when fuel was cheap and school administrators were not confronted with the potential negative effect of fuel costs on educational programs. In order for school administrators to deal effectively with the total energy problem, energy conservation programs cannot be limited just to facilities but must include comprehensive analyses of the transportation program.

The U.S. Department of Transportation has developed a document entitled Encouraging School Transportation Effective Energy Management (ESTEEM), which is intended to provide guidelines for conserving fuel and controlling student transportation costs. This

publication is an important reference for school administrators concerned with school transportation energy costs.

A comprehensive evaluation and development of an efficient school transportation system may include the following:

— Rescheduling and rerouting of buses.

— Development of a regular preventive maintenance program including engine tune-up and correct tire pressure.

— Driver training for fuel-efficient driving.

C. MERCER COUNTY, WEST VIRGINIA - A CASE STUDY

The Mercer County Schools, located in southeastern West Virginia, with an enrollment of 15,000 students, completed a comprehensive evaluation and improvement of a student transportation program that was implemented on the opening day of school in the fall of 1980.

As a result of rerouting and rescheduling, the transportation functions that required 102 buses in 1979 now require 94 buses. At $15,000 per year, per bus, the estimated potential savings or cost-avoidance is $120,000. The improvement program also resulted in a reduction of 620 miles per day at an estimated saving of $33,000 in fuel costs. Bus stops were reduced by approximately 1,240 per day or 230,000 per year through elimination or consolidation. Based on an estimate that 20 stops and starts consume 1 gallon of gasoline, this result is estimated to save $15,000 in gasoline costs. In addition, considerable savings will result in engine, clutch and brake maintenance costs. A

training course on driving techniques for fuel economy was developed and conducted for all of the bus drivers. To achieve maximum fuel economy a planned maintenance program, using electronics and infrared equipment for periodic tuning of the buses, was recommended. A regular tire pressure maintenance program was also suggested. While all of the initiatives should result in significant fuel and dollar savings, the actual savings will not be known until fuel consumption data is compiled and analyzed throughout the year. The Superintendent of Schools, John M. Hughes, considers the project to be a major step in meeting the fuel cost problem.

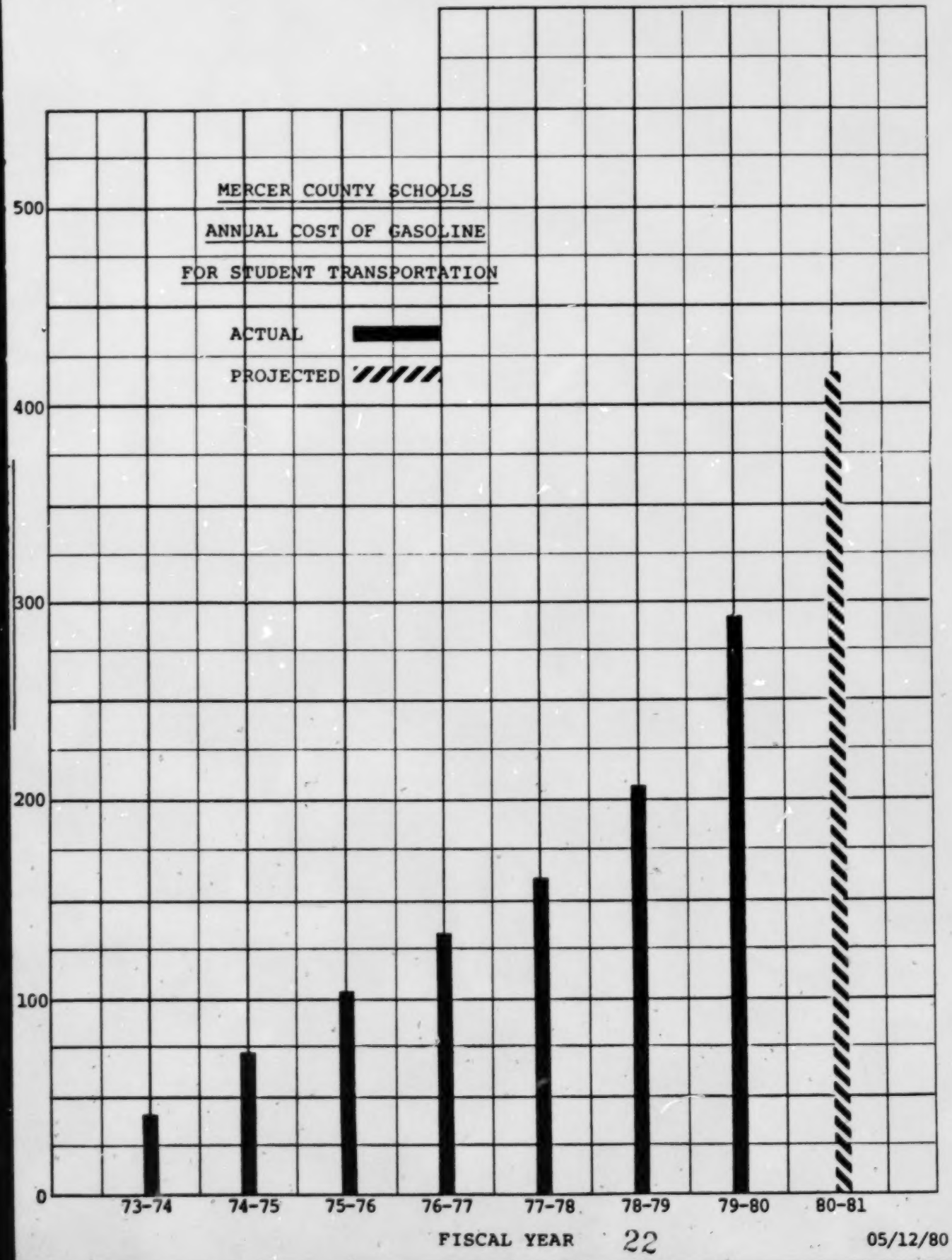
Due to the physical characteristics of Mercer County, most of the scheduling and rerouting was done manually. Computer applications are available for performing these services. Whichever approach is taken, every school district has an opportunity to begin fuel economy management as part of its regular management practices. Programs should be implemented to purchase, plan, drive, route, schedule and maintain for greater fuel economy. More pupil-miles-per-gallon is attainable through fuel economy management. School administrators must be reminded that the transportation program is an essential element in the overall school system energy management program, and that equal attention must be given to efficient operation of school buses as well as school buildings.

III. SUMMARY AND CONCLUSIONS

The problem is quite clear. Rising energy costs may force educational decision-makers to curtail educational programs. The solution is just as clear. Energy conservation programs must be initiated immediately in order to prevent the degradation of the quality of educational programs. Proven methods for energy conservation exist for applications in both facilities and school transportation programs.

Implementing a successful district-wide energy conservation program will necessitate participation and, more importantly, a committment by virtually everyone in the district. The outcome of such a program is unquestionably worth the time and effort required to make it successful. Energy and dollars will be saved, thus reducing the impact that the world energy problem has upon the educational systems in this country.

EXHIBIT 1



05/12/80

WEX Corporation - Completed Technical Assistance Projects

CLIENT	FACILITY	AREA (FT2)	PROJECTED SAVINGS(%)	PROJECTED SAVINGS($)	ECM COSTS $	PAYBACK (YEARS)
Calhoun Co. Board of Ed.	Calhoun County H.S.	60,605	40	5,421	40,950	7.6
Mercer Co. Board of Ed.	Silver Springs Elem.	12,434	55	2,137	28,180	13.2
Mercer Co. Board of Ed.	Cumberland Hts. Elem.	16,663	44	2,354	17,925	7.6
Mercer Co. Board of Ed.	Sun Valley Elementary	10,937	49	3,151	26,235	8.3
Ritchie Co. Board of Ed.	Creed Collins Elem.	30,418	38	2,500	26,310	10.5
Ritchie Co. Board of Ed.	Harrisville Elem.	23,819	44	2,765	30,840	11.2
Ritchie Co. Board of Ed.	Pennsboro High School	9,744	59	2,202	8,940	4.1
Ritchie Co. Board of Ed.	Harrisville H.S.	22,078	56	5,570	28,225	5.1
Ritchie Co. Board of Ed.	Smithville Elementary	6,000	26	518	3,750	7.2
Ritchie Co. Board of Ed.	Pullman Elementary	5,035	22	208	1,255	6.0
Mineral Co. Board of Ed.	Vocational-Tech. Cent.	62,600	40	27,040	50,950	1.9
TOTALS		260,333	43(avg)	53,866	263,603	4.9

EXHIBIT 2